

*What is claimed is:*

1. A Fourier transform processor comprising:

- a) an input sample delivery circuit for delivering a sample set of a one of  $N_f$  time domain samples and  $N_f$  frequency domain samples in a row and column order;
- b) at least one row and column circuit with an input and an output, and the row and column circuit performing a row and column transform on complex valued samples at the input to produce at the output coefficients corresponding with an other of the time domain and the frequency domain; and
- c) at least one sliced radix circuit of order "R" with R parallel inputs coupled to said input sample delivery circuit and an output coupled to the input of said at least one row and column circuit, and said at least one sliced radix circuit transforming  $N_f/R$  input samples from the sample set into a selected one among the R possible complex outputs and the deliveries of the sample set to said at least one sliced radix circuit corresponding in a number with the number of remaining ones among the R possible complex outputs.

2. The Fourier transform processor of Claim 1, wherein said input sample delivery circuit further comprises:

a downstream communication circuit for processing downstream packets each including a respective frequency domain sample set of a portion of a channel of data destined for a subscriber;

an upstream communication circuit for processing upstream packets each including a respective time domain sample set of a portion of a channel of data from a subscriber; and

an input memory for consecutive delivery of each of said sample sets.

3. The Fourier transform processor of Claim 2, wherein said input sample delivery circuit further comprises:

logic for correlating the upstream packets and downstream packets with a corresponding protocol together with a variable size  $N_f$  of each of the sample sets on the basis of a corresponding indicia within each of the upstream and downstream packets; and

logic for configuring each of said at least one row and column circuit together with said at least one sliced radix circuit responsive to the correlating of said logic for correlating.

4. The Fourier transform processor of Claim 2, wherein the downstream packets and upstream packets collectively include more than one X-DSL communication protocol.

5. The Fourier transform processor of Claim 1, wherein said input sample delivery circuit further comprises:

logic for folding the set of  $N_f$  samples into a first two dimensional array of Y rows and X columns;

logic for decomposing each of the Y rows into a second two dimensional array with R columns corresponding in a number with the order of the radix and Z rows, and with each of the Z rows comprising one of the selected subsets and with each sample within each of the Z rows corresponding with an interleaving of a corresponding one of the Y rows at a sample separation substantially equal to  $X/R$ .

6. The Fourier transform processor of Claim 1, wherein said input sample delivery circuit further comprises:

logic for determining that a sample set of  $N_i$  samples includes exclusively real valued time domain samples; and

logic for compressing the sample set to  $N_f$  samples by expressing corresponding pairs of real values samples as a single complex valued sample, wherein  $N_f$  substantially equals half of  $N_i$ .

7. The Fourier transform processor of Claim 1, wherein said input sample delivery circuit further comprises:

logic for determining that the sample set includes frequency domain samples which exhibit hermetian symmetry; and

logic for limiting the sample set to include only  $N_f$  samples by excluding any mirror reversed conjugates there from.

8. The Fourier transform processor of Claim 5, wherein said at least one row and column circuit includes:

a first row and column circuit coupled to the output of said first sliced radix; and  
a second row and column circuit coupled to the output of said second sliced radix.



with a radix R transformation of the R inputs from each of the selected subsets to a selected one among R complex outputs;

completing row and column transforms on the complex outputs generated in said act of generating; and

repeating the generating and completing acts for each of a remaining ones of the R complex outputs, to transform the  $N_f$  samples of the sample set to the other of the frequency domain and the time domain.

13. The method of Claim 12, wherein the selecting act further comprises the acts of:

accepting upstream packets each including time domain samples and downstream packets each including frequency domain samples and each of the upstream and downstream packets corresponding with selected ones of a plurality of upstream channels of data and downstream channels of data respectively; and

correlating each of the upstream packets and downstream packets with a corresponding protocol together with a size  $N_f$  of the sample set on the basis of a corresponding indicia within each of the upstream and downstream packets.

14. The method of Claim 13, wherein the corresponding protocols correlated in said correlating act include X-DSL protocols.

15. The method of Claim 12, wherein the selecting act further comprises: successively selecting sample sets of both varying sample sizes  $N_f$  and domain characteristics.

16. The method of Claim 12, wherein the selecting act further comprises the acts of: determining that a sample set of  $N_i$  samples includes exclusively real valued time domain samples; and

compressing the sample set to  $N_f$  samples by expressing corresponding pairs of real values samples as a single complex valued sample, wherein  $N_f$  substantially equals half of  $N_i$ .

17. The method of Claim 12, wherein the selecting act further comprises the acts of:

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determining that the sample set includes frequency domain samples which exhibit hermetian symmetry; and

limiting the sample set to include only  $N_f$  samples by excluding any mirror reversed conjugates there from.

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18. The method of Claim 12, wherein the selecting act further comprises the acts of:  
folding the set of  $N_f$  samples into a first two dimensional array of Y rows and X columns;

10 decomposing each of the Y rows into a second two dimensional array with R columns corresponding in a number with the order of the radix and Z rows, and with each of the Z rows comprising one of the selected subsets and with each sample within each of the Z rows corresponding with an interleaving of a corresponding one of the Y rows at a sample separation substantially equal to  $X/R$ .

15 19. The method of Claim 12, wherein said generating act further comprises the acts of:  
selecting from a set of  $R_1^2$  scale factors associated with a radix R transform a selected subset with  $R_1$  scale factors;

multiplying each of the R samples within the  $N_f/R$  subsets by a corresponding one of R scale factors within the selected subset;

20 summing products of each of the multiplications in said act of multiplying; and  
multiplying resultants of said summing act by a corresponding twiddle factor to produce the selected one among the R complex outputs.

25 20. The method of Claim 12, wherein said completing act further comprises the acts of:  
configuring the row and column transforms to correspond with a number of samples  $N_f$  in the sample set.

30 21. The method of Claim 12, wherein said completing act further comprises the acts of:  
correlating the sample set with one of a frequency domain and a time domain;  
varying the row and column transforms responsive to the correlating act.